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TITLE: Process for forming silicon oxide film

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CLAIMS:

We claim:

1. A process for the formation of a silicon oxide film, comprising the steps of: exciting a gas, comprising an organosilane or organosiloxane gas constituent and a gas constituent containing H and OH, above a substrate in a reaction chamber thereby to cause the gas constituents to react with each other in a gaseous phase or on the substrate and thereby to deposit a thin film of an organic-group-containing silanol, silanol polymer, or siloxane-bonded polymer on the substrate; and removing the organic groups from the thin film to obtain a silicon oxide film.
2. A process according to claim 1, wherein said organosilane or organosiloxane comprises at least one member selected from the group consisting of tetraethoxysilane, tetramethoxysilane, tetramethylsilane, tetramethylcyclotetrasiloxane, octomethylcyclotetrasiloxane, diacetoxy-di-tertbutoxysilane, hexamethyldisiloxane, and their substituted compounds.
3. A process according to claim 1, wherein said gas containing H and OH is water vapor or hydrogen peroxide.
4. A process according to claim 1, wherein said thin film contains 90% by weight or less of the organic groups prior to said step of removing the organic groups from the thin film to obtain a silicon oxide film.
5. A process according to claim 4, wherein said thin film contains 20 to 60% by weight of the organic groups prior to said step of removing the organic groups from the thin film to obtain a silicon oxide film.
6. A process according to claim 4, wherein said thin film contains 30% by weight or less of the organic groups prior to said step of removing the organic groups from the thin film to obtain a silicon oxide film.
7. A process according to claim 6, wherein said excitation time is sufficiently short such that the organosilane or organosiloxane gas or its reaction product still contains the organic group when it reaches the substrate.

8. A process according to claim 1, wherein said excitation is conducted in a pulsing manner.

9. A process according to claim 1, wherein said step of deposition is performed at a temperature in the range of from -50.degree. to 450.degree. C.

10. A process according to claim 9, wherein the step of deposition is conducted at a temperature in the range of from room temperature to 250.degree. C. and the step of removing the organic groups is performed by a heat treatment step at a temperature in the range of from 250.degree. to 450.degree. C.

11. A process according to claim 10, wherein said thin film is irradiated with ultraviolet rays simultaneously with or subsequent to the heat treatment step.

12. A process according to claim 1, wherein the step of removing the organic groups is performed by a heat treatment step at a temperature in the range of from 250.degree. to 850.degree. C.

13. A process according to claim 1, wherein the step of deposition and the step of removing the organic groups are successively performed without breaking the vacuum.

14. A process according to claim 1, wherein the flow rate ratio of the gas containing H and OH to the organosilane or organosiloxane gas is 1/10 to 50 times the stoichiometric molar ratio necessary for completely hydrolyzing or oxidizing the organosilane or organosiloxane with the gas containing H and OH.

15. A process according to claim 1, wherein the step of removing the organic groups comprises subjecting the thin film to a plasma treatment.

16. A process according to claim 15, wherein said plasma treatment is conducted at a temperature in the range of from room temperature to 450.degree. C.

17. A process according to claim 16, wherein a silicon oxide film having a desired film thickness is formed on the substrate by alternatively repeating the step of deposition and the step of plasma treatment in the same chamber.

18. A process according to claim 17, wherein the step of deposition and the step of plasma treatment are alternately conducted by intermittently stopping the supply of the organosilane or organosiloxane to the reaction chamber.

19. A process according to claim 17, wherein said excitation is performed in a pulsed manner.

20. A process according to claim 16, wherein said plasma treatment is performed by an oxygen, a hydrogen, or a water plasma and the substrate temperature is 100.degree. to 250.degree. C.

21. A process according to claim 20, wherein after the steps of deposition and plasma treatment, the heat treatment is performed at a temperature of 250.degree. to 450.degree. C.

22. A process according to claim 1, wherein at least one member selected from a phosphorus source, a boron source, and an arsenic source is introduced together with the organosilane or organosiloxane and the gas containing H and OH to incorporate at least one member selected from phosphorus, boron, and arsenic into the thin film.

23. A process according to claim 1, wherein a gas containing nitrogen is introduced together with the organosilane or organosiloxane and the gas containing H and OH to incorporate nitrogen into the thin film.

24. A process according to claim 1, wherein oxygen gas is, further, continuously or intermittently introduced into the organosilane gas or organosiloxane gas and the gas containing H and OH.

25. A process according to claim 1, wherein said deposition is performed through the use of a planar-type plasma CVD system under conditions of a pressure in a range of from 5 to 15 Torr, a temperature in a range of from room temperature to 250.degree. C., a distance between electrodes in a range of from 6 to 25 mm, a gas flow rate in a range of from 100 to 18000 cm.sup.3 /min, an RF (discharge) frequency of 13.56 MHz, a pulse